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Abstract

LATTICE STUDIES AT CHALK RIVER AND THEIR INTERPRETATION

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1. Since the 1958 Geneva Conference, two new facilities for lattice tests have been brought into use at the Chalk River Nuclear Laboratories:

   - a zero-power D_2O-moderated lattice-test reactor (ZED-2) was commissioned in September 1960; it is 336 cm in diameter and 333 cm high.

   - a high-pressure high-temperature loop has been installed in the ZEEP reactor for studies of single rods at 280 °C.

2. The principal systems studied in ZED-2 have been

   - a charge of 7-element NPD bundles (each element is natural UO_2, density 10.2 g/cm^3, 2.40 cm in diameter and clad in 0.51 mm of aluminum).

   - a charge of 19-element CANDU bundles (each element is natural UO_2, density 10.45 g/cm^3, 1.42 cm in diameter and clad in 0.45 mm of Zircaloy-2).

   The CANDU bundles were surrounded by simulated pressure tubes and calandria tubes of aluminum. Zircaloy-2 pressure tubes have been used for some "few-rod" experiments. Measurements have been carried out over a range of hexagonal lattice spacings from 18 to 36 cm with coolants of D_2O, He and a hydrogenated polyphenyl whose approximate formula is $C_{18}H_{22}$.

3. The following lattice parameters have been measured (though not all for each lattice)

- buckling
- neutron density distribution in cells
- fast-fission ratio
- initial conversion ratio
- neutron temperature
- Westcott epithermal spectrum index (r)

4. Neutron spectrum parameters for 19-element CANDU bundles were also measured at high temperatures in the ZEEP loop with air and a range of H_2O-D_2O mixtures as coolants.

5. In addition, some measurements have been carried out with close-packed blanket-type lattices of uranium metal rods; the rods were both natural and depleted (0.26 wt%^{235}U), 3.25 cm in diameter and clad in 1.0 mm of aluminum. Measurements were carried out over a range of square lattice spacings from 4.06 cm to 8.13 cm with both D_2O and H_2O moderators.

6. The two-group calculation of lattice parameters described in 1958 has been continuously adjusted to fit new experimental data as they were obtained, and this adjustment is embodied in the POOOF computer program for reactor optimization studies. For more detailed and fundamental studies an advanced computer program, LATREP, is nearing completion and has been used for some comparisons with experimental results.

7. A second approach is the LATTICE ANALYSIS computer program which uses observed values obtained from the above intra-cell measurements to compute the basic parameters of the two-group four-factor criticality formula. This allows a detailed comparison between measurements and parameter values determined theoretically and, in principle, enables the determination of lattice buckling from intra-cell measurements.

8. Analytical treatments of slowing-down spectra and thermal-neutron spectra have been compared with measured values.